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Science Learning Through Interactive Teaching Method: An Experimental Study

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Abstract: *An experimental study was conducted to find the impact of interactive teaching method on science learning. 70 students from seventh grade were selected to participate in this study. A control group with 35 randomly assigned students was taught by the traditional lecture method, and an experimental group with another 35 students was taught by an interactive teaching method. A pre-test was conducted prior to implementing the intervention to measure the baseline score, while a post-test was administered to measure the impact of the intervention. An ANCOVA (Analysis of Covariance) was used to find the significant difference in science achievement score of students between the traditional teaching method and interactive teaching method after controlling the effect of pre-test scores. There was a significant difference in students' science achievement score between students in the traditional teaching group and students in the interactive teaching group, F(2, 67) = 153.47, p <.001 = .82. It was concluded that the interactive teaching method significantly improves student science learning.*

Key Words: Interactive Teaching, Science, Experiment Study

Introduction

Sustainability in this demanding era seems impossible without having a technologically and scientifically sound educational environment. In this global age, science has become the backbone for progress in every field of life. It is essential to teach students with a more appropriate teaching method to equip them with the necessary scientific foundation. Various new methods and models are used to teach science subject in developed countries as well as in developing countries, including demonstration method, discussion method, performance-based method, and interactive model of science instruction is one of them. According to Bennet (2003), the prime aim of science education is to help students understanding scientific ideas. The lack of motivation in science subject due to the traditional lecture method is one of the major cause of students drop-out in science classes. Recent trends of students shifting from science to business studies indicate that students and parents do not consider much scope in the science field.

Student learning is affected by various internal and external factors. Teacher's pedagogical practice is one of the major factors that contribute to what, how, and how much students learn. Studies have been carried out in Pakistan to examine children's learning outcomes in the core school subjects, including science. Teaching science is a great challenge in a number of developing countries. Inappropriate and unproductive teaching approaches are responsible factors for lowering the achievement level of students in science. At the secondary education level, a variety of instructional techniques are not adopted by both teachers and students, which can make them able to deal with scientific concepts (Abimbola, 2013). For enhancing the interest of students and maximizing their achievement ration in science learning, alternative teaching strategies can play a vital role (Ajaja, 2013).at

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the same time, for taking innovative and active teaching strategies into the class fruitfully, scientifically enlightened teachers are unavoidable (Oyelekan & Olorundare, 2015). According to Halai (2008), In Pakistan, for effective science education, teaching methods, rote memorization-based assessment and availability of scientific aids are important factors. An integrated curriculum coupled with capable teachers showing readiness for change can only be an effective package for science.

Students are afraid of learning science just because of overloaded book, the poor printing quality of the book, untrained science teachers and lack of scientific equipment (Nayyer, 2016). Teaching science cannot and should not be dependent on teachers' viewpoint but on students as well who usually perceive things differently (Salvin, 2005).

Educational settings usually exhibit three possible teaching-learning situations, passive, active and interactive. In the first situation, learners face one-way delivery of information. It is appreciated in case of stuffing the audience with the bulk of information in a very limited time. Active and interactive classroom settings fully allow students to put up and fix their queries with a slightly different pattern. Active learning provides students with an opportunity to share their views with the teacher, while interactive teaching poses a platform for a communicative activity in which they can reflect upon what they think and do not only with the teacher but with each other also (Atanasescu & Dumitru, 2017).

Cooperation is a significant element in interactive learning that involve face to face interaction for mutual success among all group members to make an artefact as well as involves process such as discussions, negotiations, and approval of the viewpoints of other group fellows (Kozar, 2010). Students are encouraged to do group task together to give better results in future also, and they learn from each other through acceptance of opinions about conflict resolution. (Altun, 2015). In 2016, it was proved that cooperative teaching is one of the suitable approaches for science by Abdulwahab, Oyelekan and Olorundare. Through computer-assisted activities, science can also be taught effectively (Gambari, Yousuf, & Thomas, 2015). Nigerian Educational Research and Development Council (2009) proposed discussion, demonstration, experimentation, and field trips as useful methods in science teaching and learning.

Different elements of interactive learning are listed and reported by researchers, and various terms were used to define interactive learning, such as cooperative learning, interdependence, face to face interaction, teamwork etc. According to Slavin (2015) when students work together in groups to accomplish some task, positive interdependence, individual accountability and confidence, plus critical thinking are developed, and social skills are inculcated in them. Instructors might use other activities along with the above mentioned to enhance students learning and to engage them in mini-lectures in the positive way inside the classroom throughout the session. Questioning to students during and at the end of class is one of the best activity to engage students in the classroom and fostering critical thinking in them. Questions might be posed by the teacher to students, students to teacher, and student to students in peer engagement. Instructor-posed questions can be helpful in arousing student curiosity as well as interest, and it may sharpen learners' thinking skills by demonstrating the application of theory to practice, plus assessing students' knowledge, skills, or attitudes, in addition to preparing students for examinations. Student-posed questions can encourage student-teacher interaction particularly by identifying areas of confusion or test understanding and formulating personal connections with course content, as well as encouraging student-student cooperation.

Results of large scale studies depict a unpleasant results of students learning outcomes in schools specifically in mathematics and science (South Asia Forum for Educational Development, 2010). While these studies provide empirical evidence of students' performance these do not focus on determining a teacher's pedagogical practice which is one of the key contributing factors in students' learning. In Pakistan, for effective science education, teaching methods, rote memorization-based assessment and availability of scientific aids are considerable threats. Therefore, an integrated curriculum coupled with capable teachers showing readiness for change can only be an effective package for science. The present study focused on how interactive teaching method can influence students science achievement and how much interactive teaching method can contribute int students' science achievement scores.

Statement of the Problem

The teaching of science in a traditional way is a major cause of students' lack of interest in a science subject, and thus it also leads to students drop-out from school. Students consider it a boring and useless subject with no practical implications. It is essential to learn science subject by experiments and activities for effective teaching and learning process of science subject.

Objectives of the Study

- To measure the growth rate in science achievement by incorporating an interactive teaching method in science class.
- To assess the impacts of interactive methodology on the student's achievement in the science subject.
- To provide recommendations for improving the existing teaching methodologies of science subject.

Hypothesis

H_{01}: There is no significant effect of interactive teaching methods on students' science achievement.

Significance of the Study

This study provides some significant benefits for teachers, parents, school administrators, and policymakers. The findings of this study are useful for science teachers in order to enhance the teaching methodologies of their prospective subjects. Secondly, results reveal the amount of variance explained in students' learning outcomes by teachers' pedagogical practices. Thirdly, this evidence base would be particularly important to feed into current reform efforts that the educational departments are engaged in for mapping out its future directions. Fourthly, results would inform policy in the context of teachers' professional development to enhance access to quality education, specifically in the area of science and other STEM subjects.

Literature Review

Hassan and Ibrahim (2018) highlighted the significance of science through sharing facts that science was taken as a topic of 60% STEM (Science, technology, engineering and Mathematics) based researches during 2010-2016 in the world. In educational institutions of developing countries, teaching science is a very vague process (Ornek et al., 2008).

Student learning is affected by various internal and external factors. Teacher's pedagogical practice is one of the major factors that contribute to what, how, and how much students learn. Studies have been carried out in Pakistan to examine children's learning outcomes in the core school subjects, including science. Tomasello (2009) concluded in his research studies on interactive teaching and students' performance that interaction and cooperation are inherited in human being. It is not a learned behavior. He argued that children grow and help each other without any expectation of reward in return; later on, these children, being adult members of society, perform different socially acceptable roles on the bases of interaction and cooperation. Similarly, In all educational situation all around the world, in business, in social sciences, general science and from primary to higher secondary and even at tertiary level, cooperation and teamwork are widely supported (Slavin, 2015). With reference to science as a subject to teach, teachers are found with misconceptions, associating low expectations from students, and being poorly equipped with scientific approaches towards teaching and learning. In 2004, Angell et al. exposed in their study that science is taken as a difficult subject just because of workload. The difficulty of science subject is indicated with graphical representations of facts, calculations, manipulations, scientific terminology, and conceptual elaboration. In 2004, Angell et al. exposed in their study that science is taken as a difficult subject just because of workload. The difficulty of science subject is indicated with graphical representations of facts, calculations, manipulations, scientific terminology, and conceptual elaboration.

The exploration of pupils' perceptions about science reveals that students have an aversion to the science subject is only based on teacher's teaching strategies and what is taught to them in the science period, as well as , is more related to how science subject is taught in the classroom. Goldenberg's (2011) studies revealed that students enjoy learning science when they are taught by mean of inquiry method, along with discovery learning, but they feel unreceptive to having to conform to the well-organized, passive methods of delivery.

The opportunity to actively participate in science learning allows producing its own reward. Students might be engaged by using interactive worksheets in science classes because worksheets seem to be able to achieve much more than traditional teaching. Furthermore, the instant learners' feedback facilitates that in-class worksheets provided permitted for concluding the when and why of students' lack of comprehension in science learning. Moreover, Hake (1997), in his study, used a variety of interactive activities in the classroom and found that creating interactive settings within the classroom motivated students of all types to participate in class activities for science, and they learn much from each other. Later, Goldenberg's (2011) study showed that even passive learners along with active students of the science disciplines were asking and suggesting ways for a more interactive approach to be implemented in their science classes for inquiry and cognitive development.

It is argued that students' learning outcome is a complex construct. The complexity arises because of its multifaceted nature. *First*, it subsumes factors with broader linkages. For instance, students' learning outcomes, on the one hand, are associated with classroom practices (Rivkin, Hanushek & Kain, 2005) and, on the other hand, also involve family background factors like the socio-economic background of students (Helland, 2007) and parental involvement (Bakker, Denessen & Brus-Laeven, 2007) that lie outside classrooms. *Second*, the impact on students' learning is mediated by teachers' characteristics - how teachers impart knowledge to students is a function of their content knowledge and pedagogical skills. Therefore, teachers' characteristics become central to classroom interaction, where learning takes place (Goldhaber & Brewer, 2000). *Third*, student learning outcomes are also a function of classroom characteristics, including class size (Blatchford et al., 2003). All these complexities of students' learning outcome measurements require different layers of data for model-building and testing. More specifically, it is to assess the impact of teachers' pedagogical practice on students' learning while considering the other important factors that have been highlighted in the research literature (e.g. Rivkin, Hanushek & Kain, 2005; Bakker, Denessen & Brus-Laeven, 2007; Blatchford et al., 2003) to have both direct and indirect effects on students' learning outcomes.

Understanding these concepts, symbols, and formulas get students away from studying science like Physics (Lozano & Cardenas, 2002). Von-Rhoneck et al. (2007) declared a lack of interest as a highly significant factor in the failure of students in science subjects. Teacher's role becomes crucial in designing an attractive and effective instructional program for science students keeping their calibre and culture in view. For making and taking science as an attractive domain, a shift is needed from traditional to active strategies of learning.

Traditional Instructional strategies commonly used for science teachings like lecture or chalk and talk method cause boredom among students. A typical and outdated standpoint that scientific rules can me memorized provoked a need for change in the method of science teaching. According to Oeleykan, Igbokwe, and Olorundare (2017) use of laboratories and models have mostly used teaching techniques in science.

Methods in Science Teaching

Durik & Harackiewicz (2007) defined the teaching method as an act of appraising students' performance, allocating time for optimizing students' skills and letting them learn as per their unique way. In Nigeria, the poor performance of students in science classes was studied and "teaching method" was extracted as a major responsible factor (Wanbugu, Changeiywo and Ndritu, 2003).

For effective and long-lasting science learning, according to Candrasekaran (2014), productive methods like cooperative learning, science enquiry and integration can be an operative approach. Candrasekaran (2004) concluded that using productive methods. Students can be more proficient in

linking information and synthesizing concepts in novel situations. Productive methods, combined with teacher's guidance keeping students' age in mind, may give desired results (Candrasekaran, 2014). Children literature should be a part of science sallybus because it can also play a vital role in enhancing their interest in science (Barclay et al, 1999). As a method of teaching, the use of notebook writing in science contributes directly to students' vocabulary at the secondary education level (Baxter et al, 2001). Productive and meaningful learning can be more focused on science through writing down expression, information and observations about life, plants, and animals. Furner (2007) further pointed out the combination of mathematics with science for polishing critical and analytical abilities like problem-solving. Leonard et al (2006) encouraged mathematics with science for the sake of uplifting student's motivation level and greatly supported the investigation, simulation, and elaboration of difficult concepts as techniques.

Koballa and Glynn (2007) studied that in science classes, usually, students prefer to have a discussion, practical work, comparative analysis of concepts. A visible structure like posing questions can be practised in science teaching for making students involved both physically and mentally, while a basis-model should also be used, which signifies prior goal setting (Oser and Baeriswyl, 2001). as Stokking (2000) emphasized, "developing link" of school science with real-life professions can be a more attractive way to motivate students. Byman (2004) also extracted the same result from a study on secondary schools of Finland that students there opted Physics courses in future perspectives mostly. Juuti et al (2010) discussed facts about students' preferences about science teaching methods; school science through creative activities increases their curiosity about the unknown phenomenon, and school science is interesting because it is related to day-to-day life. Girls in science classes favored learning through group projects, debates, discussion, and industrial visits (Juuti et al.,2010).

The lecture method is one of the most practiced methods at the secondary education level, but it cannot be useful like an active teaching strategy (Berry, 2008). According to Al-Rawi (2003) focus of the lecture the method is on facts and figures, not on the student. Bok (2006) highlighted another disadvantage of the lecture method in science that students cannot retain much of the content.

In the words of McKee, Williamson and Ruebush (2007), for the subject of science, "demonstration" is a more useful method of teaching if reasonable time is allocated for the purpose. The demonstration, as compare to hands-on activities, can provide abundant time to observe the situation (McKee, Williamson and Ruebush, 2007). As recommended by Johnson, Johnson & Tjosvold (2006), a deliberative discussion addressing the critical problem with the aim of emerging consensus should be initiated in the science classroom. Putting up dialogue and controversies in science teaching as a method may lead students to have insights into complex phenomenon (Daniel & Canjander, 2010). Controversies as also described by Smith (2003) as an effective strategy for students to learn about positive and agreed with others' point of view.

Miles (2014) suggested activity-based methodologies for science teachers like research-oriented projects which may trigger student to student interaction with the purpose of learning. There is a shift from active learning to Peer Instruction (PI) / interactive settings now. PI is an approach enhancing mutual interaction in classroom. But peer instruction approach cannot be successful without possessing social skills at the end of students (Rosenberg, Lorenzo, and Mazur, 2006). Students must have ability to share their thoughts and convince other fellows with their point of view (Mazur, 1997). Turpen and Finkelstein (2010) presented a protocol of "Peer Instruction" as mentioned by Mazur i) questions will be modelled first ii) time will be allocated for thinking on questions iii) individual answers will be reported iv) discussion on the answers by other students v) submission of revised answers vi) feedback vii) explanation and implication of final/correct answer. According to Crouch, Watkins, Fagen and Mazur (2007) declared "convincing your fellow" as a crux of PI approach which depends on socialization ability.

Methodology

An experimental study design was used to find the impact of interactive teaching method on science learning. A science test paper was designed to measure students' science learning. A pre-test was

conducted to measure baseline scores before the intervention and post-test were conducted after the intervention to measure the impact of treatment.

Research Design

For this study, ANCOVA (Analysis of Covariance) was used, which is the combination of ANOVA and regression analysis. Any ANOVA design can become an ANCOVA design by the addition of a covariate variable. The induction of covariate increase statistical power and reduced bias by equating groups on one or more variable. Thus, it is very important to partial out the effect of the pre-test score in order to determine the actual mean differences of science achievement scores between the control and treatment group. The dependent variable was the post-test score; the independent variable was the control and experimental group, while the pre-test score variable was considered as a covariate variable.

Instruments

An achievement test of science was used for data collection. A test paper was developed from the first four chapters of the book prescribed by the government. There were thirty objective type questions in the test paper, including multiple-choice questions and fill in the blanks.

Participants

There were 70 participants randomly selected for this study from five different schools in Hyderabad district, Pakistan. These were all male students from age 12 to 14 years. These 70 students were randomly divided into two groups: control group (n = 35) and experimental group (n = 35).

Procedure

A test paper was developed for students. This test paper was also evaluated by subject experts to ensure content validity. First, the pre-test was conducted for both the control and experimental group to gather the baseline data. Students of both groups (i.e., control and experimental) were taught by the assigned teacher for one class of 35 minutes each day. The same content material was used for control and experimental groups but with the different teaching method. The first group was taught science through an interactive teaching method, and for the second group, the traditional teaching method was used. Threats to experimental validity were controlled by the researchers. Both groups were taught four chapters from the textbook. After the completion of four chapters, a post-test was taken from both groups. The post-test was identical to the pre-test.

Data Analysis

Data were analyzed using both descriptive and inferential statistics. Analysis of Covariance (ANCOVA) was the main statistical test used in this study. The purpose of using ANCOVA was controlling the effect of the pre-test score. The collected data were tabulated, analyzed in the SPSS (v.22) and the significance level was set at $p < 0.05$.

Findings

A single-factor between-subjects analysis of covariance (ANCOVA) was used to measure the significant difference between the traditional teaching method and the interactive teaching method after partialing-out student pre-test scores. Prior to analyzing the data, all the ANCOVA assumptions, including homogeneity of slopes, homogeneity of variance, and normal distribution assumptions were tested and results revealed that all statistical assumptions were tenable. There was no significance interaction between pre-test and post-test scores which is one of the key assumption of ANCOVA. There was a significant difference in students' science achievement score between students in traditional teaching group and students in interactive teaching group, $F(2, 67) = 153.47$, $p < .001$ $\eta^2 = .82$.

Table 1. ANCOA Result

Tests of Between-Subjects Effects						
Dependent Variable: PostTest						
Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared
Intercept	6278.49	1	6278.49	178.30	<0.01	0.73
PreTest	143.94	1	143.94	4.09	<0.05	0.06
Group	10655.70	1	10655.70	302.60	<0.01	0.82
Error	2359.32	67	35.21			
Total	300656.00	70				
Corrected Total	13167.49	69				

a. R Squared = .821 (Adjusted R Squared = .815)

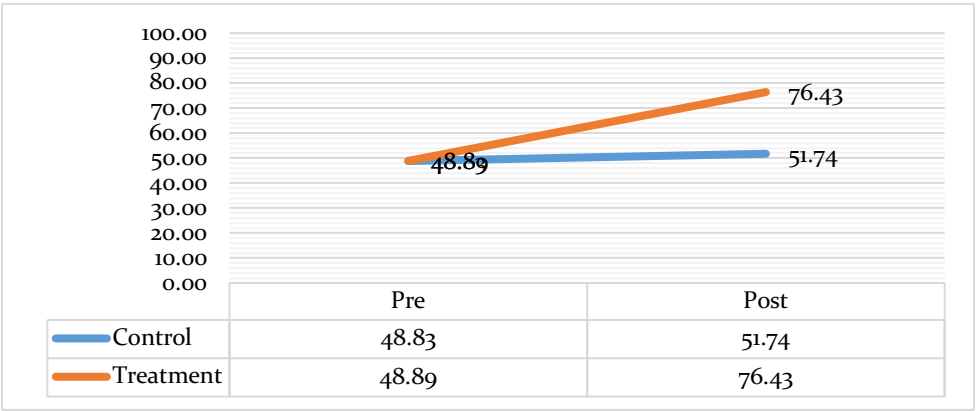

Figure 1. Mean Scores of Pre-test and Post-test in Control and Treatment Group

The data depicted in Table 1 and Figure 1 depict that there was a significant difference in students' science achievement score between students in the traditional teaching group and students in the interactive teaching group, $F(2, 67) = 153.47$, $p < .001$ $\eta^2 = .82$. Therefore, the null hypothesis 'There is no significant effect of interactive teaching methods on students' science achievement' is failed to reject.

Discussion

The purpose of this study was to assess the impact of interactive teaching on students' science achievement. An experimental design was used to find the significant difference in science achievement of students between a control group using the traditional teaching method and an experimental group using an interactive teaching method. Results revealed that 82% variation in science achievement score is due to the interactive teaching method.

Ebrahim (2012), in his experimental study "comparing the effectiveness of lecture method and interactive learning on students' achievement in science subject/s and their use of social skills" with a sample of 163 elementary female science students of the same grade found that students who were taught by interactive method showed a significant academic achievement and social skills as compared to those students who were taught by using the traditional method. Similarly. Reza, Abozar, Ali and Akbar (2013), in their research study, indicated that interactive teaching is much more significant at the elementary level.

Ahmed and Mahmood (2010), in a comparative analysis of the study of the effectiveness of different teaching methods traditional instruction, loosely structured cooperative learning and students team achievement on students' academic success, concluded those students who were taught in the experimental group enjoyed their learning. Similar results were found in the current study.

Traditionally, in Pakistani public schools, science teaching relies heavily on lectures, reading, and teacher-centred demonstrations with very little involvement from the student's side. It is, therefore, important to shift science teaching from the traditional method to the interactive method in order to gain students interest in a science subject at the elementary school level.

Conclusions

In this era, one of the indicators of educational performance as an end product is the achievement of students in subject areas. Achievement in science subjects is given a unique accentuation by policymakers since it manages the ideas and rules that are needed for innovatively and technologically developing societies. This study provides empirical evidence to support the interactive teaching method in a science subject at the middle level. This study was conducted in one district with a limited sample. This is one of the major limitations of this study. Another limitation was that only seven-grade science students were tested from four chapters in their prescribed book. Despite these limitations, this study provides some significant benefits for teachers, parents, school administrators, and policymakers. The findings of this study are useful for science teachers in order to enhance the teaching methodologies of their prospective subjects**.**

Recommendations

As the study assessed the impact of interactive teaching on students' science achievement and found that the students' scores increased significantly due interactive teaching method, so it is recommended that interactive teaching methodology may be used by teachers of elementary schools. Focus on utilizing innovative and interactive methodologies may be given in pre-service teacher education programmes. In-service training sessions may be organized for elementary-level science teachers to familiarize them with interactive teaching methodologies.

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